Europa Reconnaissance Traceability Matrix

Goal		Objective		Investigation		Measurement	Short name	Model Instrument	Priority	Areal coverage (km)		Number of sites imaged		Incidence angle range (degrees)		Spatial resolution (m/pixel)		Local time of day range (hr)		Spectral characteristics	Coincident instrument	Rationale for Change
										Baseline	Floor	Baseline	Floor	Baseline	Floor	Baseline	Floor	Baseline	Floor		Baseline	
Characterize Scientifically Compelling Sites, and Hazards, for a Potential Future Landed Mission to Europa	SC. Characterize the surface properties of potential landing sites on Europa	Assess the distribution of surface hazards, the load-bearing capacity of the surface, and the regolith thickness of at least 15 sites of interest for a future landed mission.	SC.1	Determine the distribution of blocks and other roughness elements within a potential landing site at scales that represent a hazard to landing.	SC.1a	~~Measure the occurrence and lengths of shadows cast by blocks protruding 1 m or more above the surface, and the abundance and nature of surface roughness elements at scales of greater than 1 m, through monochromatic imaging at a spatial resolution on the surface of better than or equal to 0.5 m/pixel.~~ Measure the occurrence of blocks protruding 1 m and more above the surface, and the abundance and nature of surface roughness elements at scales as small as 1 m.	Blocks	Reconnaissance Camera (RC)	R1	5x10	2x10	40 total sites over the life of the mission; Up to 4 (stereo) images are anticipated to be obtained when the trajectory dips sufficiently below 50 km c/a altitude and 1 when c/a altitude is approximately 50 km; any image must meet baseline lighting conditions to count against the baseline total	15 total sites over the life of the mission; Up to 4 (stereo) images are anticipated to be obtained when the trajectory dips sufficiently below 50 km c/a altitude and 1 when c/a altitude is approximately 50 km; any image must meet baseline lighting conditions to count against the floor total	~~20-80~~ 45-70		0.5	0.5			Monochromatic		General: (1) Addition of columns for Baseline and Floor "Number of sites imaged" and "Goal" under "Incidence angle range (degrees)." Columns added for clarity and need to identify Baseline and Floor for number of sites based on discussion with the Project Scientist; Specific: (1) Addition of wording to quantify the baseline and floor number of sites to be imaged. Based on discussion with the engineering team, Louise Prockter, and the Project Scientist; (2) Clarify that the incidence angle range of 45 to 70 degrees is a goal rather than a baseline or floor; based in discussion with the Project Scientist and Louise Prockter; (3) The Reconnaissance Goal was modified based on conversation among the Project Scientist, Project Manager, Program Scientist, and Program Executive.
					SC.1b	Characterize the fractional area of block coverage and the areal distribution of roughness elements by measuring the contrast in thermal emission between at least 2 spectral channels at local times of day between 10 AM and 3 PM and at a spatial resolution on the surface of better than or equal to 250 m/pixel.		Thermal Imager (ThI)	R2	5x10	2x10					better than or equal to 250	better than or equal to 250	10-3 pm	10-3 pm	2+ spectral channels	Recon camera	
			SC.2	Determine the distribution of slopes within a potential landing site over baselines relevant to a lander.	SC.2a	~~Measure surface slopes of up to 25° on a 30-50 m baseline for all azimuths by acquiring images with a spatial resolution of better than or equal to 10 m/pixel.~~ Measure surface slopes of up to 25° on a 3 m baseline for all azimuths by acquiring stereo paired images with a spatial resolution of ~~better~~ than or equal to 0.75 m/pixel.	Slopes	~~Topographic Imager (TI)~~ Reconnaissance Camera (RC)	R1	~~5x10~~ 5x10 (>90% cross- and down-track overlap)	~~2x10~~ 2x10 (>90% cross- and down-track overlap)			~~45-80~~ 20-70 (each pair); 15-30 convergence angle	~~60-70~~	~~better than or equal to 7~~ better than or equal to 0.75 m/pixel	~~better than or equal to 10~~			Monochromatic		Restores orginal measurement and requirements; Change to revert to orginal discussed by project science and techical team at 2 June 2014 meeting and concurred by full SDT at 3 June 2014 meeting
					SC.2b	Characterize the statistical distribution of slopes from nadir track altimetric information having a relative height accuracy of 1 m.		Ice Penetrating Radar (IPR)	R3	SAME AS SCIENCE TRACEABILITY MATRIX											Recon camera	
			SC.3	Characterize the regolith cohesiveness and slope stability within a potential landing site.	SC.3a	Determine the regolith-component thermal inertia (distinct from blocks) of the upper decimeter-scale surface layer by measuring the contrast in thermal emission between at least 2 spectral channels at local times of day between 10 AM and 3 PM and at a spatial resolution on the surface of better than or equal to 250 m/pixel. Require sufficient albedo accuracy to facilitate accurate reduction of temperature data.	Regolith cohesion	Thermal Imager (ThI)	R3	SAME AS 1B												
					SC.3b	Identify small scale landforms associated with mass movement from monochromatic stereo image data at a spatial resolution on the surface of better than or equal to 0.5 m/pixel.		Reconnaissance Camera (RC)	R3	SAME AS 1A												(1) For the measurement, specify that stereo image data will be acquired; based on engineering team analysis and discussion with Louise Prockter and the Project Scientist
			SC.4	Determine the regolith thickness and whether subsurface layering is present within a potential landing site.	SC.4a	Characterize the depth of regolith to "bedrock/ice" at the cm-scale by measuring the daytime and nighttime contrast in thermal emission between at least 2 spectral channels for a spatial resolution on the surface of better than or equal to 15 km/pixel and at local times of day between 10 AM and 3 PM and 3 AM and 6 AM. Require sufficient albedo accuracy to facilitate accurate reduction of temperature data.	Regolith thickness	Thermal Imager (ThI)	R2	5x10	2x10					better than or equal to 15000	better than or equal to 15000	10-3 pm, 3 - 6 am	10-3 pm, 3 - 6 am	2+ spectral channels	Recon camera	
					SC.4b	Identify small scale landforms associated with exposed layers from monochromatic stereo image data at a spatial resolution on the surface of better than or equal to 0.5 m/pixel.		Reconnaissance Camera (RC)	R3	SAME AS 1A												(1) For the measurement, specify that stereo image data will be acquired; based on engineering team analysis and discussion with Louise Prockter and the Project Scientist
	SV. Characterize the scientific value of potential landing sites on Europa	Assess the composition of surface materials, the geologic context of the surface, the potential for geologic activity, the proximity of near surface water, and the potential for active upwelling of ocean material of at least 15 sites of interest for a future landed mission.	SV.1	Characterize the composition and chemistry of potential landing sites with an emphasis on understanding the spatial distribution and degradation state of endogenically derived compounds.	SV.1a	Identify the presence of relevant endogenically derived compounds by measuring surface reflectance over the wavelength range of 850 to 5000 nm at a spatial resolution of better than or equal to 300 m/pixel.	Composition	Shortwave Infrared Spectrometer (SWIRS)	R1	5x10	2x10					300	300			Less than 2500 nm @10nm spectr. res., 2500-5000 @ 20 nm spectr. res.	Recon camera	General: Modification to goal based on discussion between NASA Program Scientist, Program Executive, and the Project Scientist
			SV.2	Characterize the potential for recent exposure of subsurface ice or ocean material and resurfacing vs. degradation of the surface by weathering and erosion processes and provide geologic context for potential landing sites.	SV.2a	Identify small scale landforms diagnostic of the local geologic history of potential landing sites from monochromatic stereo image data at a spatial resolution on the surface of better than or equal to 0.5 m/pixel.	Degradation	Reconnaissance Camera (RC)	R2	SAME AS 1A												(1) For the measurement, specify that stereo image data will be acquired; based on engineering team analysis and discussion with Louise Prockter and the Project Scientist
					SV.2b	Identify landforms diagnostic of the regional geologic history of the surface that include potential landing sites through imaging at a spatial resolution on the surface of better than or equal to 50 m/pixel.		Topographic Imager (TI)	R2	100x100	25x100			45-70 (prefer 70)	20-80	5	50			Stereo	Recon camera	
			SV.3	Characterize the potential for shallow crustal liquid water beneath or near potential landing sites.	SV.3a	Identify and characterize the nature of subsurface thermal or compositional horizons and structures related to the current or recent presence of water or brine within the region from 100 meters to 3 km at 10-meter vertical resolution.	Crustal water	Ice Penetrating Radar (IPR)	R2	SAME AS SCIENCE TRACEABILITY MATRIX											Recon camera	
					SV.3b	Acquire surface topography on the order of 250-m horizontal scale and better than or equal to 20-m vertical resolution and accuracy extending a lateral distance from the ground trace sufficient to cover the width of the subsurface profiles.		Topographic Imager (TI)	R2	SAME AS SCIENCE TRACEABILITY MATRIX											Recon camera	
			SV.4	Characterize anomalous temperatures (that are significantly out of equilibrium with expected nominal diurnal cycles) indicative of current or recent upwelling of ocean material at or near potential landing sites	SV.4a	Determine the presence of surface temperatures in excess of diurnal equilibrium indicative of active or recent extrusion, upwelling, or outgassing at each potential landing site by measuring thermal emission at local times of day between 10 AM and 3 PM and at a spatial resolution on the surface of better than or equal to 250 m/pixel.	Temperature	Thermal Imager (ThI)	R3	5x10	2x10					better than or equal to 250	better than or equal to 250	10-3 pm	10-3 pm	1 spectral channel	Recon camera	